ANNUAL REPORT

OF THE

Canal Zone Experiment Gardens*

For the Fiscal Year 1930

* Succeeding the Canal Zone Plant Introduction Gardens.

THE PANAMA CANAL PRESS
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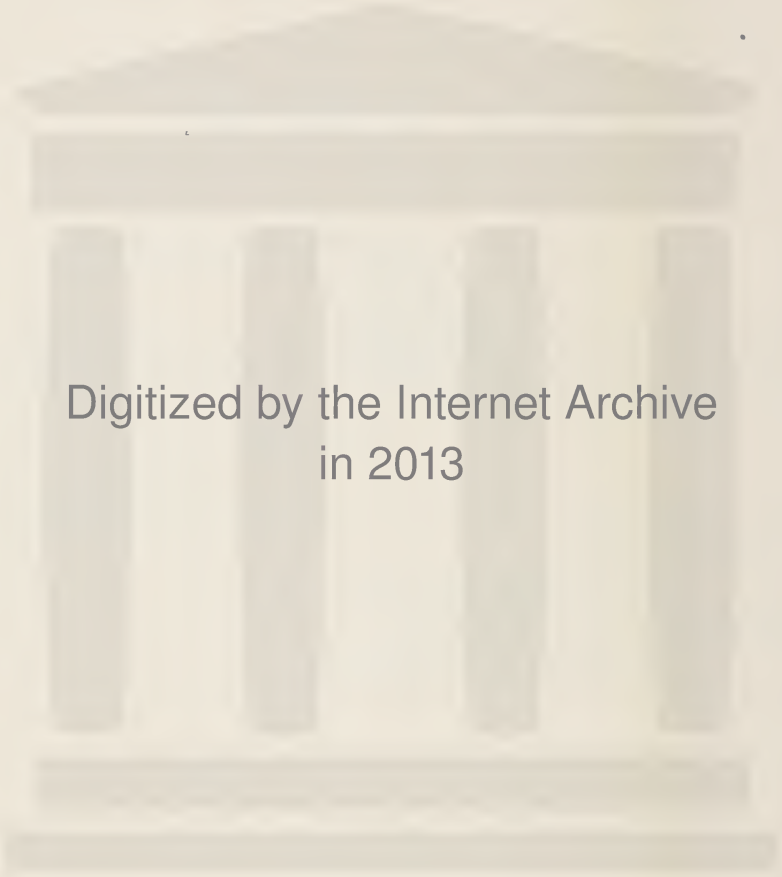
LETTER OF TRANSMITTAL.

CANAL ZONE EXPERIMENT GARDENS,
Summit, C. Z., *July 16, 1930.*

SIR: I have the honor to transmit herewith and to recommend for publication, the Annual Report of the Canal Zone Experiment Gardens, for the year ending June 30, 1930.

Respectfully,
J. EDGAR HIGGINS,
Director.

Mr. ROY R. WATSON,
Chief Quartermaster,
Balboa Heights, Canal Zone.
Through Mr. J. H. K. HUMPHREY,
Assistant Chief Quartermaster.



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ILLUSTRATIONS.

PLATES.

ERRATA

Three illustrations have been misplaced in the final setting up of this publication. That shown as Plate IV, Fig. 1, should bear the title *An unidentified orange—received as "Valencia."* The title of Plate VI, Fig. 1, should read *The Temple orange.* The title of Plate VI, Fig. 2, should be *Marsh grapefruit.*

Therefore on page 17, "Plate IV, Fig. 1" should read Plate VI, Fig 2. On page 19 the second sentence should read as follows: Plate IV, Fig 1 indicates the heavy bearing of an unidentified variety of orange which came to the Gardens under the name "Valencia" and similar productivity in the Temple variety is shown in Plate VI, Fig. 1.

PLATE I.

Gate at main entrance.

p. 6—a.

ANNUAL REPORT

OF THE

CANAL ZONE EXPERIMENT GARDENS FOR 1930

BY

J. Edgar Higgins, *Director.*

General Statement.

In the Annual Report of the Canal Zone Plant Introduction Gardens for 1929, it was mentioned in a footnote that the name of the Gardens had been changed to Canal Zone Experiment Gardens. No explanation was given at that time, but an announcement of the change and the reasons for the same has been sent to all on the general mailing list. The new name represents a slight change in organization, but the functions and objectives of the institution remain the same, the new designation being given to better represent the purposes being pursued rather than to indicate any change in policy.

The objectives of the work as now carried on, were rather fully set forth in the Annual Report for the fiscal year 1928. From time to time new spheres of usefulness appear, or old ones are enlarged. During the year just closed, the Gardens were honored with a visit from the representatives of the Institute of Educational Research of Teachers' College of Columbia University in connection with their survey of the schools of the Panama Canal Zone, under the direction of Dr. N. L. Engelhardt. Doctor Engelhardt laid emphasis upon the relationship of the Experiment Gardens to educational problems in the Canal Zone.

A sphere in which the Gardens are now serving the United States, as a whole, is that of supplying tropical plant material to conservatories and to research workers as well as to those who are testing such cultures in the most nearly tropical portions of the Union. The number of such calls seem to be considerably on the increase.

The work that is being done here may be regarded as the laying of the foundations of an institution which should become a great out-of-door laboratory for scientific research in the problems concerning tropical plants in relation to their environment of soil, climate, and other plant and animal life. Such research is inevitable if the agriculture of this Central American and tropical South American region is to progress. Capital is ready to enter into such developments as soon as safe investments can be pointed out, secured by a knowledge of the conditions and of the necessary technique. Such developments will benefit the United States, not only by furnishing profitable investment for surplus capital, but also in supplying tropical raw materials necessary in manufacture. The relation of all of this to the income from the operation of the Panama Canal need not be emphasized. It is patent to everybody that such developments must be followed by increased tonnage in transit and increased collections in tolls. The benefits that would accrue to Panama and to the neighboring republics from such agricultural developments are too obvious to require any elaboration. The Governor of the Canal has pointed out the great benefits, in international relations, mutual understanding and good will which might be expected to be brought about by a university, located in the Canal Zone, and serving the surrounding region. This may be regarded as an expansion of the same thought which the Governor has had in mind in fostering the development of plant research in the Canal Zone.

It would seem clear therefore that the same broad view of the significance of the work that has been begun at Summit should be generally recognized in the United States as well as here in the Canal Zone, and in the entire surrounding region. The Congress of the United States has made provision for such investigational work in Hawaii, Puerto Rico, Guam, and the Virgin Islands. Although it is not designed to make the Canal Zone an important agricultural country, the strategic importance of its location with reference to the agricultural development of the surrounding region and the relation of such development to the economics of our own country should not escape the attention of the people of the United States. With a vision of the importance of an agricultural center here, The Panama Canal has begun this work and carried it on to the extent of available funds. But the time seems to have come when the project should be recognized as of national and international significance.

To point out some of the needs that are outstanding, mention may be made of the fact that there is, so far as we are aware, no soil specialist in the public service anywhere in this region and no soils laboratory. Likewise there is no plant pathologist to study the diseases of plants

or methods of combating them. Practically nothing is known of the plant diseases here, except in so far as they are identical with those found elsewhere, and no survey has been made to learn what diseases do exist here. A botanist is much needed whose time could be devoted exclusively to gaining a wider and more intimate knowledge of the wild plants, many of which are of economic value, and also to gaining a knowledge of the physiology of the cultivated plants. These are a few of the outstanding needs, from the standpoint of plants and soils.

Publications.

In addition to the Annual Report, there was published during the year, the "Revised Catalogue of the Principal Plants at the Canal Zone Plant Introduction Gardens." Mimeographed lists of "Plants for sale at the Canal Zone Experiment Gardens" have been issued and distributed locally and to correspondents in the neighboring Republics. This is not sent out to the general mailing list in the United States and foreign countries as most of the plants covered in this enumeration are intended for use on the Isthmus or in nearby locations and can not easily be shipped long distances by mail. A copy of this list will be mailed to any botanic garden or experiment station, if requested.

Improvements.

The activities of the year have included rather more attention than usual to certain improvements other than plantings.

The irrigation system.—Chief among these improvements is the irrigation system, the pressing need for which was mentioned in the Annual Report for 1928. A special allotment of approximately $14,400 was set aside by the Governor of The Panama Canal for this purpose, of which $7,200 was made available for the fiscal year 1930, and the balance for 1931. Estimates of the amount of water that will be required at the Gardens were submitted by the Director, and the plans were drawn up by the engineers of the Department of Operation and Maintenance. The work of installation has been conducted by the Municipal Division of the same department. The 36-inch main pipe-line, which passes the west and lower side of the Gardens and conducts water from the Chagres River to the Miraflores Filtration Plant, was tapped with a 36-inch by 10-inch T near the entrance to the Gardens. The pump house was rebuilt and a new electrically operated single stage pump with $12\frac{1}{2}$-horsepower motor and capacity of 300 gallons per minute, was installed. The main pipe line was laid parallel to the

general direction of the main road through the Gardens and leading near to the upper boundary. This line consists of about 50 feet of 10-inch, 500 feet of 8-inch, 1,000 feet of 6-inch, and 1,000 feet of 4-inch and 3-inch pipe. Where necessary Ts and valves or plugs were installed to provide for connecting the main distribution lines which are to be laid during the coming year. The few distribution lines of the old system were connected with the new main line so as to keep these in service and distribute water where possible. By the careful conservation of the funds of the regular allotment for the operation of the Gardens, it was possible to make some extensions of the distribution lines, including the laying of a 3-inch pipe through a part of the avocado orchard and the balance with a 2-inch pipe, which made it possible for the first time to get any considerable volume of water to this orchard. In some parts of the Gardens, water was conducted to the points where it was most needed by the installation of 2-inch fire hydrants and the use of condemned fire hose bought from the obsolete storehouse. This was a great aid in emergency. Several hundred feet of movable surface pipe, now much used in the Pacific Coast States, was bought from the general operation funds. This was shifted from place to place as needed. By all of these and other devices a much larger quantity of water was applied than had been possible in any previous year.

Directing signs.—Several signs have been erected for the guidance of visitors who may be unfamiliar with the Gardens. In some instances strangers who had come out from town in hired cars had been carried on the highway far beyond the road that turns off to the Gardens. A sign was put up at this junction to avoid repetition of such errors on the part of chauffeurs. Another sign was put up at the entrance indicating the directions to the office and to the nurseries and the Garden plantings. A third was placed on the office building.

Road to office.—A suitable road leading to the office building has always been greatly needed. The only approach has been along the edge of the Panama Railroad right-of-way, and so close to the siding as to be unsafe when freight cars were on the rails, as well as unsightly. Also, it was impossible for large trucks to get through to the cars without breaking the plants along this approach. A short piece of macadamized road leading directly to the office has been constructed which will add much to the convenience, the safety, and the appearance of the approach, and which also opens up a vista through a part of the Gardens where many interesting plants are brought into view, and where others will be planted. Plate II shows a part of this little piece of road on which

PLATE II.

Part of circle in road to office.

p. 10—a.

plantings have not yet been completed. This road has been constructed at only nominal cost because of the availability of waste material which had to be cleared away from the floor of the nearby stone quarry, and was therefore supplied and loaded without charge by the Municipal Division. The hauling was done almost entirely by the regular transportation facilities of the Gardens, and the work, except the rolling, was all performed by the regular labor gangs. Technical advice was supplied by the Municipal Engineering Division.

A short piece of concrete walk has been constructed leading from the circle of the road to the office entrance.

Road repairs.—No other new roads have been built during the year, but considerable repairing has been done on the old roads, including the oiling and sanding of the driveway which circles toward the center of the Gardens.

Entrance gate.—A new iron gate and reinforced concrete pillars, designed by Mr. C. A. Black, has been erected by the Constructing Quartermaster's Division to replace the old wooden gate which had decayed and had been taken away some time ago. This strong and substantial gate at the entrance, which is shown in Plate I, is very much in keeping with the surroundings and adds greatly to the appearance of the place, while it affords protection against intruders at hours when the Gardens are not open to the public. The necessity for such protection has been brought forcibly to our attention on many occasions.

Fence.—A new fence with iron posts has been built leading from the entrance gate to the south boundary where it joins the fences of the Cattle Industry pastures; and also another from the entrance gate northward to the office building. With another small gate which must be built near the office to close the entrance into the mango orchard, these fences will complete the much needed protection on the side next to the highway and to the railroad station.

Office repairs.—The office has undergone some repairs during the year, and a half of the interior has been repainted. Minor repairs have been made on some of the sheds and other buildings. These necessary improvements have been paid for out of the regular funds for operation.

Ditching.—Considerable ditching has been done in some parts of the Gardens to take care of the excess of water during the rainy season. This is very important as there are many places where nothing will grow until this excess water is removed. So far only open ditches have been attempted.

Vine supports.—Two galvanized iron pipe trellises have been built for the support of many economic and ornamental vines. These are

plain pipe trellises set in concrete footings and connected with ordinary wire at suitable distances for the support of the vines. Their combined length is approximately 200 feet.

A manure spreader for the fly problem.—Organic manures are absolutely essential to the permanent success of the Gardens. Fortunately there has been a liberal supply of these materials available, but it is necessary so to use them as to avoid the breading of flies. Until this material is well aged, it will breed flies if placed among our plantings by the usual method of handling with forks. During the year just closed an attempt has been made to solve this problem in part by the use of a farm manure spreader. This machine can easily be operated, in many of the plantings, and can be adjusted to spread even coarse material very thinly. It is claimed to spread as thinly as four tons per acre. Although no exact measurements of the area covered have been made, the spread appears to be thin enough to render the material uninviting to flies as a breeding place. The application can be repeated often enough to give a liberal supply, as each application soon disappears either in rainy weather or in the dry season.

Library increments.—Through the kind cooperation of the officials of the United States Department of Agriculture, the Gardens have received many valuable departmental publications, including sets, as nearly complete as possible, of the back numbers of the Experiment Stations Record, the Journal of Agricultural Research, the bulletins of the Technical series, Farmers bulletins, Year Books of the Department of Agriculture, and others. The new numbers of all of these are being received as issued. The older sets and the new numbers make exceedingly valuable additions to the reference library and their receipt is gratefully acknowledged. Publications are being received from several agricultural experiment stations and botanic gardens in the United States. Other publications have been received as exchanges from botanic gardens and experiment stations in foreign countries. As funds are available, new volumes are being added each year by purchase. By all of these means a valuable working library is being built up.

Herbarium.—Under an arrangement entered into by the United States National Museum and the Governor of The Panama Canal, relating to the botanical investigations carried on in the Canal Zone by Mr. Paul C. Standley, a very fine herbarium collection of 1,137 species of plants, collected from this locatility and identified by Mr. Standley, came into the possession of the Government of The Panama Canal during the year and has been placed in the custody of the Experiment Gardens. Through the generosity of Dr. Thomas Barbour, whose interest in the Canal Zone is well know, six insect-proof metal cases were donated for

The Meyer lemon (synonyms, Hsien Yuang—Fragrant lemon—Chinese ornamental lemon).

the proper care and preservation of this collection. Our sincere thanks are expressed to Doctor Barbour. The collection and the cases for its preservation will greatly aid the work of the Gardens.

Citrus.

The year has afforded a very good opportunity for observation of the citrus fruits, as the trees of most of the varieties have come into bearing and produced a very good crop. Of course, too much confidence should no be placed in the results of one year's performance, but those who are interested in extending citrus plantings will be desirous of securing such data as are available.

The Meyer Lemon.

The most outstanding citrus fruit of the year has been a new lemon (Plate III), named the Meyer[1] in honor of the late Mr. Frank Meyer, who introduced it from China where it is known as the Hsien Yuang, or fragrant lemon. It is also called the Chinese ornamental lemon. The latter designation would seem to be appropriate if it did not convey the idea that the fruit is valuable only as an ornament, for it is one of the most beautiful of all the varieties of lemons. Also this name is too long and does not conform to the rules of pomological nomenclature. The color of the fruit, whether ripened on the tree or by ordinary curing methods or by the recent ethylene gas treatment, is a clear lemon yellow of rather brighter hue than that of most commercial lemons. The rind is smooth and up to the present time has shown no Verrucosis or scab, although this disease is present but not prevalent in the Gardens. It is thin and cures well, becoming quite leathery, although no long distance shipping tests have been made to determine its resistance to abrasions. The form of this fruit is somewhat less elongated than in most varieties, some specimens being almost spherical with the nipple practically absent. The juice is of excellent quality and exceedingly abundant, as will be seen by reference to the tabulation presented below. The crop was heavy for trees in their first year of bearing.

Samples of the Meyer lemon were submitted to the General Manager of the Commissary, including lots of medium and of large-sized fruit, cured and uncured in each case. The following tabulations (Tables 1 and 2) were submitted by the manager as the result of analyses made by the chemist:

[1] McKee, Roland, 1926. Chinese Dwarf Meyer Lemon Introduced, U. S. Department of Agriculture Yearbook, 1926. 218–221.

TABLE 1.—ANALYSES OF LEMONS.

RESULTS ON WHOLE LEMONS.

Sample.	Weight.	Pulp.	Rind.	Seeds.	Juice.	Juice.
	Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*cc.*
States	124	23.0	36.4	0.4	40.2	48
	129	22.4	36.8	0.3	40.5	50
	119	19.3	36.9	0.3	43.3	49
	131	23.5	36.7	0.5	39.3	49
	122	21.7	33.7	0.5	44.1	51
	107	25.8	29.6	.....	44.6	45
States, average	122	22.6	35.0	0.4	42.0	49
Meyer, Lot 1, large size, uncured	307	21.7	25.1	1.1	52.1	154
	331	21.6	19.3	1.1	58.0	186
Meyer, Lot 1, large size uncured, average	319	21.7	22.2	1.1	55.0	170
Meyer, Lot 2, medium size, uncured	236	21.5	21.3	1.1	56.1	127
	243	20.2	19.8	0.9	59.1	137
Meyer, Lot 2, average	239.5	20.8	20.6	1.0	57.6	132
Meyer, Lot 3, large, cured	194	19.9	11.9	1.4	66.8	123
	217	19.3	17.9	1.4	61.4	127
Meyer, Lot 3, average	205.5	19.6	14.9	1.4	64.1	125
Meyer, Lot 4, medium, cured	149	19.6	13.8	0.8	65.8	94
	143	21.5	10.8	1.2	66.5	90
Meyer, Lot 4, average	146	20.6	12.3	1.0	66.1	92
Lemons from Messina, Italy	116	20.2	43.9	2.6	33.3	36
	124	19.5	39.2	3.9	37.4	44
	119	19.7	39.3	4.1	36.9	42
	104	21.7	30.5	3.3	44.5	44
	102	22.4	34.3	5.5	37.8	37
	105	22.3	39.1	3.7	34.9	35
Italian, average	111	21.0	37.7	3.8	37.5	40

TABLE 2.—RESULTS ON CLARIFIED LEMON JUICE.

Sample.	Sp. Gr. 20°/4° C.	Rotation 26° C 200 mm. ov	Acidity as citric acid.	Sucrose	Invert sugar.	Total sugars.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
States	1.0367	−0.36	6.28	0.26	1.50	1.76
Meyer, Lot 1	1.0255	+0.31	3.94	0.14	1.89	2.03
Meyer, Lot 2	1.0295	−0.99	4.82	0.21	1.67	1.88
Meyer, Lot 3	1.0288	−0.93	4.84	0.13	1.67	1.80
Meyer, Lot 4	1.0307	−0.92	5.16	0.09	1.78	1.87
Italian	1.0407	0.00	7.67	0.15	1.06	1.21

These comparative analyses of lemons from the United States and from Italy seem to indicate that the Meyer variety, from China, as grown at the Canal Zone Experiment Gardens, were superior to the imported lemons, in all respects covered by the analyses except that the juice contained a slightly lower percentage of citric acid. Taking the Meyer Lot 4, medium size and cured as the most comparable, the tabulation shows that the juice of these contains 5.16 per cent acidity, expressed as citric acid, while the juice of the United States lemons, analyzed, contained 6.28 per cent acidity. But the quantity of juice in the Meyer, averaging 92 cubic centimeters per fruit, is so far in excess

of that shown by the lemons imported from the United States, which averaged only 49 cubic centimeters per fruit, that the actual citric acid content of the Meyer is far in excess of that shown in the imported stock. While the Italian lemons showed a still higher ratio of citric acid in the juice, the amount of juice was correspondingly lower. A rough calculation which has been made seems to indicate that if lemons were bought on a basis of total citric acid content alone, the Meyer as represented by those samples, would be worth about 50 per cent more money than the imported lemons that were taken as samples from the Commissary stock.

For comparison of the States lemons used in these anlayses, reference may be made to Bul. No. 93 of the University of California Agricultural Experiment Station, which shows an average juice content in Eureka lemon amounting to 38 cubic centimeters, while those imported from the United States and shown in the above tabulation averaged 49 cc. The citric acid content in the California analyses averaged 7.66 per cent, that is to say, the fruit analyzed at the University of California showed a higher percentage of citric acid, but a correspondingly lower juice content.

It is to be noted that the percentage of acidity, in the juice of lemons, increases as moisture is lost in the process of curing. The Meyer fruits sent from the Experiment Gardens were rather lightly cured while the imported fruit was of course fully cured before being shipped and doubtless had lost some moisture, after shipping, by exposure to the air.

It would therefore appear that the Meyer, for local consumption at least, is equal in every respect to the imported lemons, if not superior to them. If considered as a lemon for export purposes, other standards than those shown in the analyses would have to be taken into consideration. The requirements of a commercial lemon are rather exacting, as is true of most commercial fruits to-day, and are somewhat fixed by custom as well as by essential characters. The market is accustomed to a decidely elongated and rather tapering lemon while the Meyer is inclined to be less elongated. Whether the unusually handsome appearance of the new variety would be sufficient to overcome the accustomed ideas as to shape in any export market would have to be taken into consideration. Those that were offered for sale at the Commissaries sold readily and were in great demand. One of the most important characters in a commercial lemon is its shipping quality and ability to endure handling and to resist decays. No opportunity was afforded for such tests in the case of the new lemon from China, except that a few were held at the Gardens for observation. Those that had been gathered as green fruits, as is customary in harvesting lemons, when possible, kept well for many weeks.

The trees of the Meyer lemon at these Gardens are of low spreading habit, vigorous and rather open growth. The tree is reputed to be dwarf. Here they are located where they receive the shade of bananas, and some Hevea rubber trees. Their behavior, under these conditions, suggests again that shade for some citrus trees, under tropical conditions, may be advantageous. This is a problem which is worthy of further investigation.

Pomelos or Grapefruit.

The term Pomelo, although recognized as the correct common name for this fruit in horticultural literature is less used than the name grapefruit by the growers, the trade, and the consumer.

Most of the trees in the citrus orchard were planted out as 1-year-old budded trees about May, 1925, and hence, at time of harvesting in January and February, 1930, had been approximately four and one-half years planted. A few of the varieties will be mentioned here because of their performance at the Gardens and their promise as fruits for further culture on the Isthmus. Several varieties of Pomelo or grapefruit have produced well and yielded fruit of excellent quality. Prominent among these is the McCarty (Syn. Indian River) (Plate IV, Fig. 2). In Florida, which is renowned for the quality of its grapefruit, this is regarded as one of the very best varieties. There is always a possibility of error in labels, but the fruits produced on the trees labeled McCarty at the Gardens, correspond rather closely to the description of this variety given by Hume[1] which is as follows: "McCarty (Indian River.) Form oblate; size large, $4\frac{1}{4}$ x 5 inches; stem small; base slightly creased; color very light yellow; rind $\frac{3}{8}$ inch thick; oil cells large, slightly depressed; sections 13, large, rather irregular; flesh grayish green; bitterness marked; acidity and sweetness normal; pulp melting; juice plentiful; juice-sacs large; quality excellent; seeds 49–59, large, long, creased; core $\frac{7}{8}$ inch, open. Season January to March.

The origin of this variety is unknown. The late C. T. McCarty, of Eldred, Florida, from whom specimens were first received, and after whom it was named, wrote as follows: "'This pomelo is known here as the Standard, or Indian River; I don't know its origin. It came here from Rockledge 16 years ago (about 1886).' One of the very best varieties. Its fruiting habit is worthy of note because it bears its fruit singly on the branches."

The fruit on the trees at the Gardens checks with the above description, except that the flesh was somewhat golden in color, rather than grayish green, the core was closed in the several specimens examined, and in one or two instances the fruits did not hang singly. There is

[1] Hume, H. Harold: The Cultivation of Citrus Fruits, 1926. New York: The MacMillan Company.

PLATE IV.

FIG. 1.—Marsh grapefruit.

FIG. 2.—McCarty grapefruit.

some evidence that environment may alter the color of flesh of citrus, and it is not impossible that other slight changes may have been brought about under the different conditions existing here. For the present, at least, this variety at Summit is being propagated under the name McCarty. Whether the identity is beyond question or not, the variety grown here is a most excellent fruit of high quality and productivity, so far as the limited experience can indicate.

Marsh (Marsh Seedless) which is the standard variety of California, presents evidence of being a good producer under Canal Zone conditions (Plate IV, Fig. 1). The form is oblate-roundish, size medium, color light yellow, flesh of good quality but somewhat lacking in the slightly bitter principle that is characteristic of most pomelos. The variety, as grown here, seems to have rather more seeds than it has in the United States, but less than are found in other varieties. Although commonly called a "seedless" grapefruit, it is not absolutely free from seeds in Florida where it originated. The nearly seedless condition is in its favor from the standpoint of the consumer, although this seems less important than formerly, as pomelos are now more carefully prepared for serving and special simple devices are on the market for removing the core and the seeds. From the standpoint of the grower, seedlessness affords some advantage, as such fruit may be held longer on the trees.

The Foster is another of the pomelos of much interest in the collection because of its precocity, its heavy production, and its highly attractive pink color of flesh and even of the rind. The trees of this variety were among the heaviest producers and carried the fruit well without any breaking of the limbs. The pink color of flesh is found in several of the pomelos or grapefruit, and is quite common in the closely related pummelo. But among the true pomelos or grapefruit, this variety, as grown in the Canal Zone, appears to combine best the beautiful color with excellent quality. Here again the character of color within the fruit seems to differ in some degree from that regarded as typical of the variety in Florida, where it originated. Hume states that "the pink color in this variety is confined to the section membranes, and often shows through to the rind." The fruit, as grown at the Gardens at Summit, although corresponding otherwise rather closely with the descriptions of Foster, is decidedly pink through the flesh and the color extends to the rind in many places.

The Duncan (Plate V, Fig. 1) is another of Florida's best grapefruit which has been doing well here and, as is true of all the other varieties mentioned, must be more thoroughly tested in different parts of Panama and the Canal Zone.

Pummelos.

The pummelo, in its best varieties, is but little known or cultivated in the Western Hemisphere, but in some of the Oriental countries it has reached a high degree of perfection and is much prized as a dessert fruit and also for its ornamental value. Although it is closely related to the pomelo or grapefruit, and by some botanists is regarded as the same species, variously determined as *Citrus decumana*, *C. grandis* and *C. maxima*, other specialists in this group place the grapefruit by itself, as a distinct species, designated *C. paradisi*, Macf. Whether the grapefruit is to be regarded botanically as only a variety of the Oriental pummelo or otherwise, it is, from a horticultural viewpoint, distinct. Everybody in this country is thoroughly familiar with the grapefruit, but perhaps some have not seen the pummelo. Without attempting here to discuss the latter botanically, it may be said that it is usually larger than the grapefruit, with greater tendency to be pyriform. Perhaps its most distinguishing character is in its juice-vesicles which are large, long and tapering, and only very loosely adhering, so that they can easily be separated without breaking and served in salad or dessert, while these vesicles, in the grapefruit, adhere so closely that they can not be separated without breaking. Hence the fruits have somewhat different uses in culinary art. In the pummelo, the segments usually have a thick leathery covering which, however, is not complete, leaving the inner pulp-vesicles exposed when the fruit is opened. As already indicated, the pulp may be light in color or almost any shade of pink. The rind may be a light yellow, as in the ordinary grapefruit, or as dark as an orange. The so-called shaddocks, of Florida and the West Indies, may be regarded as seedling pummelos, and some are probably worthy of being propagated by budding. But the best pummelos of the Orient have been propagated by air-layering, or Chinese layering, for centuries. The Amoy pummelo is renowned in China, while Siam has several varieties of great merit.

Some of the pummelos of the Orient have been introduced into the Canal Zone, through the United States Department of Agriculture. One of the Siamese pummelos, known as Kao Pan, S. P. I. No. 14,012 (Plate V, Fig. 2), fruited at Summit in February and March. The following is a brief description: Form, pyriform with prominent neck and with apex flattened; rind, light orange yellow, $\frac{1}{4}$ inch to $\frac{3}{4}$ inch thick except at neck where it is $1\frac{1}{2}$ inches thick; flesh, tender, of good flavor, golden yellow in color and having fairly abundant juice.

FIG. 1.—The Duncan grapefruit.

FIG. 2.—The Kao Pan—A Siamese pummelo.

Oranges.

Several varieties of oranges have yielded heavily, for trees so young, and have produced a good quality of fruit. Plate VI indicates the heavy bearing of an unidentified variety of orange which came to the Gardens under the name "Valencia" (Fig. 1.), and also similar productivity in the Temple variety (Fig. 2). The Pineapple, Plate VII, Fig. 1, which is "Florida's most important midseason sweet orange," is one of the most promising varieties on the Isthmus in point of quality and apparent productivity. It ripens in January and February.

The variety introduced under the name "Valencia," from Costa Rica, has been another heavy producer of oranges of good quality. It appears to be different from the true Valencia, and ripened much earlier, in fact at the same season as Pineapple, while fruit of the true Valencia in the same orchard from other sources was still immature.

The Temple is usually regarded as a hybrid between the sweet orange and the mandarin or loose-skinned orange, although its origin is unknown. The rind is easily separated from the pulp, but is not so loose as in the mandarin. The flesh is of good quality and free from rag. The illustration shows a decided inclination to free bearing habits.

Treatment of Citrus Fruits.

Nearly all of the citrus fruits harvested at the Gardens were submitted to several treatments in preparing them for sale. It may be said parenthetically that all fruits not required for experimental purposes are sold, usually through the Commissary Division. It seems desirable that some description of these processes of treatment be given here as some of them at least are much needed in the handling of the crop of oranges and grapefruit on the Isthmus.

The first process is washing with soap and water and is now common in good citrus practice. Regularly prepared citrus washing powders are much used, and of course, in commercial practice the work is done by machinery and the fruit is brushed with mechanically operated soft brushes which remove the dust, the sooty-mold, and the few scale insects which may be found, but the washing process must not be attempted as a substitute for insect control in the orchard. When the washing is completed, the fruit passes to a rinsing bath where the soapy water is removed. The second treatment which is now rather extensively used in California is the bicarbonate of soda bath for the control of various decays. This consists in passing the fruit through a solution composed of three pounds of bicarbonate of soda per hundred pounds

of water, in which the fruit remains from three to five minutes. This process also, although seemingly very beneficial in preventing decays, is never considered as a substitute for the extreme care in picking, grading, packing, and shipping which has become standardized in good citrus practice. Here in the tropics where fungi multiply so rapidly, it would seem that this treatment might be especially valuable. But it is doubtful whether it would be of much use in the keeping of oranges that are gathered by the usual crude methods, thrown in bulk into trucks and then carried to market. Such oranges must be sold at once and be consumed at the earliest possible moment or heavy losses by decay are inevitable. On the other hand it might be possible to do successful business and extend the season of available seedling oranges by buying these on the trees, carefully picking and grading them, selling the small and inferior grades at once, and after cleaning and otherwise treating those of first grade, placing them in cold storage for the return of better prices than those that prevail during the height of the orange season.

The third process, which was used on nearly all citrus fruits at the Gardens during the year, was the ethylene gas treatment to produce attractive coloring. It is well known that oranges and grapefruit, especially in the tropics, frequently become ripe before they have acquired the desired color. The lack of color detracts much from their appearance and market value. Gases, especially ethylene, have now come into very general use, in cases where the color acquired on the tree is not sufficient. For the purpose, it is only necessary to have a tight room, and a drum of ethylene gas equipped with gauge with which to measure the volume of gas that is allowed to escape in the ripening room. With this equipment, it is all very simple and anyone can soon acquire familiarity with the operation, but it is important to remember that the gas is inflammable and in 5 per cent concentration with air is explosive, but no such concentrations are ever required. There is some difference of opinion and practice as to the amount of gas used, the concentration varying from 1 cubic foot of gas per 1,000 cubic feet of air to 1 to 5,000. In some cases, the greater concentration is used for the first few hours and followed by less concentrated mixtures, until the fruits are properly colored. The best results seem to be attained by exposures of a few hours followed by a brief period of ventilation before the gas is again applied. In the experiments followed at the Gardens, the following are some of the results obtained: Meyer (Hsien Yuang) lemons, all green when picked, exposed mostly in 6-hour periods, at concentration of 1 part to 3,000 became well colored after 32 hours of exposure. Oranges and grapefruit, half-colored when harvested, exposed for 2 hours at 1 to 3,000, 2 hours at 1 to 5,000, and two 4-hour periods at the same concentration, making a total of 12 hours exposure, all became fully

PLATE VI.

FIG. 1.—An unidentified orange—received as "Valencia."

FIG. 2.—The Temple orange.

colored. Again, oranges and grapefruit, estimated to be one-third colored, were exposed 2 hours at 1 to 3,000 and 14 hours in divided periods at 1 to 5,000. All were well colored after this total of 16 hours exposure. All of this work, of which the above will serve as examples, was under the immediate supervision of the foreman, Mr. W. C. Dewey.

Ethylene Gas and Fruit Ripening.

The foregoing reference is to the use of ethylene gas in the ripening of citrus fruits. Experiments in its use with some other fruits also have been conducted. One of the fruits used was the Bungulan (erroneously Lacatan) banana. Much difficulty has been reported with this variety on the ground that it frequently fails to color well in ripening and also that the fruit falls from the bunch when ripe. The bananas selected were of two different degrees of maturity, one lot being "full," as the fruit is described when the fingers have become quite rounded and have lost their angular appearance. The other lot was such as is called "three-quarters full." Those two lots were treated with ethylene in the proportion of 1 cubic foot of gas to 3,000 cubic foot of air, the treatment being continued for three 2-hour periods each day for 3 days making a total of 18 hours exposure. The chamber was ventilated between each treatment and was left open at night as it was not practicable to continue treatment at night. At the close of the treatment the bananas of both grades had taken on a beautiful clear yellow color but practically all of them fell from the bunches as soon as they were handled. The flavor of the fruit was excellent in both lots. These results do not help to establish confidence in the Bungulan as a commercial fruit since it is essential that such must hold tenaciously to the main stem of the bunch.

Mango fruit has also been treated with ethylene as a means of rapid ripening. As mentioned in earlier reports, most mango fruits ripen during rainy season and with the exception of a few varieties they are very susceptible to Mango Anthracnose or "blight," which causes the spotting and rotting of the fruit. Sometimes the fruits split and decay upon the tree, but often they will withstand the disease fairly well until harvested, after which the fungus growth proceeds more rapidly than the ripening process and the fruits decay before they are ready to be eaten. The treatment with ethylene hastens the ripening, apparently without speeding up the fungus growth proportionately, and by this means it has been possible to save some fruit for immediate use. It is possible that the washing of the fruit immediately after harvesting with bicarbonate of soda, as described elsewhere for the treatment of citrus fruit, might further tend to preserve it.

Rice.

Rice is one of the most important sources of food supply in Panama. In 1927, rice was imported to the value of 380,228 Balboas,[1] and in the first half of 1928 the importation was valued at 302,461.43 Balboas. No statistics are at hand for the second half of the year, but it would appear that importation is increasing. In almost all of the inhabited parts of the Republic, there is an abundance of idle land which could be used to produce upland rice, so that any one living in the country districts could easily raise sufficient rice for family use and never be in need of this food which is the staff of life to a very large proportion of the human race and is freely used by all races. One acre of the higher yielding of the upland varieties at the Gardens would produce sufficient rice for the use of an average family for one year.

The varieties of rices mentioned in the Report for 1929 have been continued in cultivation and seed has been distributed without cost to all who have requested it. It has been announced in the press in both English and Spanish that trial lots of seed were being distributed without charge. Twenty varieties of these rices were planted in the trial plots in drills, Plate VII, Fig. 2. In the case of some varieties very poor stands were secured due to poor germination or the carrying away of the seeds by birds. In other varieties the stand was very good. At harvest time, an estimate was made of the percentage of stand. The actual yields were calculated on an acre basis, and are shown in the accompanying table. No calculations have been made on a basis of 100 per cent stand.

Table 3.

PHILIPPINE VARIETIES.

Acc. No.	Name.	Per cent of stand.	Paddy per acre, pounds (calculated).
6680	Kinanalig	95	1,481
6715	Pinulot	50	714
6711	Dinagat	90	2,142
6714	Initlog Dalog	85	997
6713	Canabungbong	90	2,528
6712	Kimarayon	80	997
6719	Pulupot	90	1,180
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	S. D. 120	80	1,089
	S. D. 117	80	635
4440	P. R. 318	90	1,270
4441	P. R. 358	75	1,361
	P. R. 422	95	1,655
	P. R. 327	90	1,440
	P. R. 388	40	917
	P. R. 343	75	1,452
	P. R. 402	75	997
	P. R. 315	85	997
4438	R. D. 249	50	459
4437	R. D. 239	50	459
	R. D. 234	75	1,045

[1] The Balboa is equivalent to the gold dollar.

PLATE VII.

FIG. 1.—The Pineapple orange.

FIG. 2.—Rice trial plots at harvest time, sugar cane trial plots in background.

Some of the yields shown in the above table may be considered high for upland rices and compare favorably with the yields in the valley of the Nile where the average is about 2,300 pounds of rough rice per acre, or with those of the rice-growing countries of South America. In British Guiana which is one of the two South American countries which produce more rice than they consume, the average yield is reputed to be about 2,450 pounds of rough rice per acre.[1] Considering that the lowland method of culture is used in those countries and that the yields are normally very much higher under this system in which the plants are partly submerged in water, the yields of upland rice, in the tests referred to, are very creditable. The advantage of the upland rice lies in the fact that it can be grown on almost any farm, while lowland rice requires a special location with abundant water and land specially prepared and dyked.

Larger quantities of seed will be available for distribution this year. It is recommended that these upland rices be sown so as to mature at the beginning of the dry season, when the danger of rains in harvest times will be past and while there is sufficient moisture in the soil to carry the plants through the ripening period. In this locality, if the seed is sown during the last week in August, most of the varieties will mature in the last of December or early in January, approximately four months from seeding. A very good practice would seem to be to plant a crop of quick maturing legumes early in the rainy season, which may be cut for cattle food just before the rice is to be planted, or they may be piled up and allowed to rot as a source of excellent fertilizer. This crop will not only enrich the soil, but, if dense, will crowd out much of the grass and weeds and thus reduce the labor of weeding the rice.

Sugar Cane.

The growing of introduced varieties of sugar cane for distribution among the cane growers of Panama has been continued along the lines indicated in the Report for 1929. One of the chief objectives in this work is to find choice canes, well adapted to the conditions in Panama and resistant to the Mosaic disease, which has been devastating in most of the cane fields of the Isthmus. Most encouraging reports have come in from the plantations concerning some of the varieties, notably P. O. J. 2725 and P. O. J. 2714. One side of the cane testing plots is shown in the background of Plate VII, Fig. 2.

[1] Copeland, Edwin Bingham. Rice, London: MacMillan and Co., Ltd.

Some Insect Troubles.

The Gardens do not attempt to carry on any technical entomological investigations and all problems in the identification of insects are referred to Mr. James Zetek, Associate Entomologist of the U. S. Department of Agriculture, located in Balboa, with whom close cooperative relations exist. Mr. Zetek has furnished very valuable information, and many identifications, including those used here. There are certain insect problems which are experienced at the Gardens and which may be of deep interest and importance to some readers of this Report who may not receive the technical publications relating to the same. For this reason, brief mention is here made of a few such problems as seen from a horticultural rather than from an entomological viewpoint.

The Papaya Fruit Fly, *Texotrypana Curvicauda* Gerst (Diptera, Trypetidae). This is a very serious pest in papaya culture. It is by no means new to the Isthmus, but has not given any trouble at the Experiment Gardens until this year. The female of this insect deposits its eggs within the papaya fruits at almost any stage of their development. The flies may easily be seen at work, and the evidence of their having stung the fruit is manifest in the milky juice which exudes from the papaya and becomes dried on the surface. This however, may result from any abrasion. Fruits in which eggs have been successfully deposited and hatched, may fall to the ground prematurely, but if the papaya is nearly full grown when stung it may remain upon the tree until ripe. Fortunately it usually is possible to recognize infested fruit by its external appearance. The fruit, when cut open, will be found to be infested with maggots and unfit for human food. The remedy which has been used at the Gardens consists in gathering all stung fruit, cutting it open, and immersing it in oil. If this practice is diligently pursued it is possible to hold the flies well in check. There appears to be also a wide variation among varieties, in their susceptibility to the attacks of the insects.

A wood-cutting beetle.—Another troublesome insect pest is one of the Longhorned Bettles (Cerambycidae), familiar to many laymen by their long antennae which are frequently lying backward over the body and often exceeding the latter in length. The species referred to here is identified by Mr. Zetek as Trachysomus Thomsoni Auriu. The adults of this insect, both male and female, girdle or completely cut off from trees whole branches, sometimes several inches in diameter. The cutting is so suggestive of the work of a beaver that the common name Beaver Beetle might well be given to this insect. The females deposit

their eggs in the severed branches which furnish the necessary deadwood upon which the larvae feed. The obvious method for the control of these insects is in the gathering of all such branches and other deadwood of the varieties affected and burning them before the adults are ready to emerge. The injury caused by these insects has been found at the Gardens in guava (*Psidium guajava*), crepe myrtle (*Lagerstroemia Indica*), and in the native forest tree *Triplaris americana*. Mr. Zetek also records the avocado among its host plants.

The Nurseries and the Revolving Fund.

It was mentioned in the Report for 1929 that a Revolving Fund had been set up for the operation of the nurseries. The purpose was to make this branch of the work self supporting, so far as it pertains to all plants other than those that are yet in a purely experimental stage, and thus to save the regular operation funds for the permanent development of the Gardens. The plan has been working out very satisfactorily. The demand for trees and plants is constantly increasing and by means of the plan just outlined it is possible to expand the nursery operations and thus to meet the need which otherwise could not be done. There is a large call for orange, grapefruit, mandarin, mango, avocado, and various shade and ornamental trees, but palms, crotons, hibiscus, bougainvilleas, coffee-rose, acalypha, and many other ornamentals are also taken in large numbers. Many new and less known things are distributed in smaller numbers as the stock becomes available.

In the propagation of avocados an attempt is being made to produce more trees in the open nursery row and less in the concrete tubes, which have been used partly because some buyers prefer to get them in this form and partly because our propagators have found it difficult to bud avocados successfully without shelter in the rainy season. But it has been found that budding can be successfully performed in the open nursery row in the dry season. Seeds that are planted in the latter part of the rainy season are in good condition to be budded when the dry weather comes. Seedlings from plantings in the early part of the rainy weather are likely to be much larger than is necessary or desirable for budding when the rains have ceased. Some experiments are now being tried with planting the earliest seed in paper pots and cleft-grafting the seedlings by the seedling graft method while they are still in tender growth. By having them in the paper pots, it is easy to invert them and dip them in melted paraffin without disturbing the root system. When these grafts are established the plants are set out in nursery row and allowed to develop. The practicability of this method for the purpose sought is yet undetermined, but the grafting is not difficult.

In mango propagation, the former practice of using cement or concrete tubes has been discontinued entirely. No difficulty is experienced by the propagators in cleft-grafting mango seedlings in the nursery row, and by this practice much stronger plants are produced. The ordinary cleft-graft is used and is covered with wax paper until union is effected and the cion has made a growth that requires the opening of the paper cap.

The chief difficulty that has been experienced during the year, in mango propagation, has been in the serious infestation of the seedlings by an undetermined species of Thrips (Physopoda). These very minute insects which are not likely to be found without the use of a good lens, infest the terminal bud causing it to cease growth. New buds on the side begin to open, but these also are quickly overcome by the Thrips and the young seedling is stunted or even killed. When in this stunted condition they will not receive and unite with a cion. Fortunately most of the varieties of the mango now being propagated do not appear to be seriously affected by this insect, but the seedlings before being grafted are very susceptible. A very effective remedy has been found in nicotine dust, applied with any good dusting gun. The important thing is to detect early the work of the insects and apply the remedy before the seedlings have had a serious set-back.

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